To: Interested Stakeholders

From: Bennett Brooks and Eric Poncelet, CONCUR

Date: March 31, 2003

Re: CALFED Water Use Efficiency Program Staff Work Group on Urban Water Use Measurement -- Compilation of Background Information on Current Urban Water Use Measurement Practices, Costs, and Benefits

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The attached memo was created to inform the deliberations of the CALFED Water Use Efficiency Program Staff Work Group on Urban Water Use Measurement. The memo contains background information describing current urban water use measurement practices, costs, and benefits. It was drafted by David Mitchell of M.Cubed.

Note: This information has not been confirmed by CALFED advisory and decision-making bodies. It is intended solely to foster informal stakeholder discussions and elicit preliminary feedback. Anyone using this information beyond the Staff Work Group is asked to appropriately characterize the nature of this material.

ATTACHMENT 4

To: CALFED WUE Staff Work Group on Urban Water Use Measurement

From: Eric Poncelet and Bennett Brooks, CONCUR

Date: March 12, 2003

Re: Compilation of Background Information on Current Urban Water Use Measurement Practices, Costs and Benefits

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Attached is a series of background information documents that has been compiled to help inform stakeholder discussions on the topic of appropriate urban water use measurement. These documents, which have been drafted by David Mitchell of M.Cubed, include the following:

- Metered and un-metered connections in CA, by customer class and region
- Cost of meter installation for different areas of CA
- Cost of sub-meter installation
- Cost-benefit analysis of recent metering proposals by California Water Agencies
- Water conservation benefits of metering / volumetric billing
- Dependence of BMP implementation upon water use measurement
- Summary of residential volumetric water rates in CA

CALFED Program staff also have assembled other background information to serve as reference material for the work group deliberations. These documents will be available at the Staff Work Group meetings. They include:

- Examples of meter retrofit plans adopted:
  - City of Fresno Residential Meter Program / Residential Meter System Evaluation
  - San Juan Water Meter Conversion Criteria – Guidelines for which meters to replace
  - Roseville Water Meter Retrofit Program
  - City of Folsom Meter Retrofit Program Plan Executive Summary and Full Plan
  - City of Davis Water Meter Retrofit Program
    - Program description
    - Financial analysis
    - Contractor installation project preliminary engineering report
    - Reference document
  - North of the River Municipal Water District's Highland Park Rehabilitation Study
  - Citrus Heights RFP for Neighborhood No. 9 Residential Meter Retrofit Project

- Canadian Water and Wastewater Association: A Guide to the Economic Appraisal of Alternative Metering Investment Strategies (Benefit-Cost Analysis Tool and Users' Manual)
- Description of volumetric billing rate structures (from CUWCC or AWWA)
- Wastewater rate survey

These documents—coupled with the accompanying companion piece on California Legal Authorities (see ***Attachment 5***)—represent CALFED WUE Program Staff's view of the most important, readily accessible background information to support Staff Work Group deliberations on the issue of urban water use measurement. Moreover, all of this information was identified as relevant by stakeholders in the Stakeholder Assessment conducted last summer. CALFED staff will work to provide additional background information as deemed necessary by the Staff Work Group.

Summary Findings:

We present below several summary findings in an effort to draw out key results from the analysis of this complex subject matter. The accompanying technical memoranda contain additional details and qualifications. We strongly encourage all work group participants to review the attached material carefully. This material will be presented and considered again during the first Staff Work Group meeting.

Status of service metering

- Much of the state is already metered
- Approximately 10% of single family residences are not metered. Approximately 3% of multifamily dwellings, 1.5% of commercial, and less than 1% of industrial customers are not metered
- The vast majority of un-metered single and multi-family dwellings are located in the Foothills, Sacramento Valley, San Joaquin Valley, and Mountains/Eastern Desert parts of the state

Service metering and water savings

- Water meters, when used in conjunction with volumetric pricing, result in water savings averaging about 20%
- Most of these savings come from reductions in the amount used for landscape irrigation or from improved leak repairs

Cost to meter existing service connections

- Variable costs (due largely to differences in existing infrastructures):
  - $500-$1000 for single family dwellings in Central Valley
  - $500-$3000 per meter for multi-family dwellings and commercial connections

Estimated cost of water saved for single family retrofits

- Cost of water saved is approximately $300/af in Central Valley
- This is relatively low cost for water in California but higher than some source acquisition costs in the Central Valley

Sub-metering

- Sub-metering of multi-family units and commercial properties is a growing practice
- Cost of sub-metering installation
  - $125-$250 per meter (new construction)
  - $225-$500 per meter (retrofits)
- Annual O&M of $24-$36 per meter
- Water savings: 10-20% of un-metered indoor use (but few reliable estimates exist)
- Unit cost of water saved from sub-metering is relatively high ($4000-$14000 / af)

Recent benefit-cost results for metering projects (CALFED grant program proposals)

- Most are locally cost-effective
- Non-locally cost-effective cases are located in regions with low stated costs of water

Metering and Best Management Practices (BMPs)

- Implementation of BMPs 3, 4, and 11 requires metering
- Evaluation of water savings from BMP implementation is dependent on records of metered water use

Again, these summary findings are best understood within the context of the specific technical memoranda from which they emerge. We recommend that readers consider the individual analyses in detail and come to the first meeting prepared with any questions or comments.

Compilation Of Background Information On Current Urban Water Use Measurement Practices, Costs And Benefits

Table of Contents:

Documents drafted by: David Mitchell
M.Cubed
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Oakland, CA 94618
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POLICY ANALYSIS FOR THE PUBLIC AND PRIVATE SECTORS
M.CUBED

Date: October 15, 2002

To: Eric Poncelet, CONCUR, Inc.
Fr: David Mitchell, M.Cubed

Re: Metered and Unmetered Connections in CA, By Customer Class and Region

The following tables summarize sample data of metered and unmetered connections in California. Metered and unmetered connections are classified by customer class and region. The sample data come from DWR's annual public water system production survey. Data for 1997 and 2000 are presented, providing two snap shots in time of the state of metered versus unmetered service for California public water systems. The regional definitions were developed by M.Cubed and are not part of the DWR data sets.

2000 DWR PWS Production Survey Data Summary

Single Family Connections:

REGION	SF Metered	SF Unmetered	Total	% Unmetered
BAY AREA	608,535	13,866	622,401	2.2%
CENTRAL COAST	254,488	1,262	255,750	0.5%
FOOTHILLS	34,208	39,392	73,600	53.5%
MOUNTAINS/EASTERN DESERT	17,766	4,973	22,739	21.9%
NORTH COAST	50,048	542	50,590	1.1%
SACRAMENTO VALLEY	109,152	125,475	234,627	53.5%
SAN JOAQUIN VALLEY	428,264	304,284	732,548	41.5%
SO. CAL. COASTAL	2,212,704	2,900	2,215,604	0.1%
SO. CAL. DESERT	578,710	6,213	584,923	1.1%
UNKNOWN	13,434	-	13,434	0.0%
Grand Total	4,307,309	498,907	4,806,216	10.4%

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Multi Family Connections:

REGION	MF Metered	MF Unmetered	Total	% Unmetered
BAY AREA	53,315	830	54,145	1.5%
CENTRAL COAST	24,019	7	24,026	0.0%
FOOTHILLS	529	1,556	2,085	74.6%
MOUNTAINS/EASTERN DESERT	676	381	1,057	36.0%
NORTH COAST	1,153	1,913	3,066	62.4%
SACRAMENTO VALLEY	7,811	2,505	10,316	24.3%
SAN JOAQUIN VALLEY	33,158	3,822	36,980	10.3%
SO. CAL. COASTAL	299,545	3,749	303,294	1.2%
SO. CAL. DESERT	13,155	455	13,610	3.3%
UNKNOWN	2,123	-	2,123	0.0%
Grand Total	435,484	15,218	450,702	3.4%

Commercial Connections:

REGION	Comm. Metered	Comm. Unmetered	Total	% Unmetered
BAY AREA	39,173	497	39,670	1.3%
CENTRAL COAST	26,213	42	26,255	0.2%
FOOTHILLS	3,625	519	4,144	12.5%
MOUNTAINS/EASTERN DESERT	2,328	647	2,975	21.7%
NORTH COAST	3,648	40	3,688	1.1%
SACRAMENTO VALLEY	16,474	1,005	17,479	5.7%
SAN JOAQUIN VALLEY	45,419	2,236	47,655	4.7%
SO. CAL. COASTAL	188,028	431	188,459	0.2%
SO. CAL. DESERT	30,457	315	30,772	1.0%
UNKNOWN	1,640	-	1,640	0.0%
Grand Total	357,005	5,732	362,737	1.6%

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Industrial Connections:

REGION	Ind. Metered	Ind. Unmetered	Total	% Unmetered
BAY AREA	3,576	-	3,576	0.0%
CENTRAL COAST	1,964	4	1,968	0.2%
FOOTHILLS	61	-	61	0.0%
MOUNTAINS/EASTERN DESERT	88	3	91	3.3%
NORTH COAST	95	41	136	30.1%
SACRAMENTO VALLEY	1,042	4	1,046	0.4%
SAN JOAQUIN VALLEY	14,442	19	14,461	0.1%
SO. CAL. COASTAL	19,617	23	19,640	0.1%
SO. CAL. DESERT	2,151	-	2,151	0.0%
UNKNOWN	-	-	-	#DIV/0!
Grand Total	43,036	94	43,130	0.2%

Landscape Connections:

REGION	Landscape Metered	Landscape Unmetered	Total	% Unmetered
BAY AREA	11,054	350	11,404	3.1%
CENTRAL COAST	3,449	40	3,489	1.1%
FOOTHILLS	979	471	1,450	32.5%
MOUNTAINS/EASTERN DESERT	60	5	65	7.7%
NORTH COAST	47	12	59	20.3%
SACRAMENTO VALLEY	1,596	93	1,689	5.5%
SAN JOAQUIN VALLEY	13,299	506	13,805	3.7%
SO. CAL. COASTAL	27,932	25	27,957	0.1%
SO. CAL. DESERT	7,779	16	7,795	0.2%
UNKNOWN	39	-	39	0.0%
Grand Total	66,234	1,518	67,752	2.2%

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Other Connections:

REGION	Other Metered	Other Unmetered	Total	% Unmetered
BAY AREA	26,789	1,569	28,358	5.5%
CENTRAL COAST	4,485	512	4,997	10.2%
FOOTHILLS	312	-	312	0.0%
MOUNTAINS/EASTERN DESERT	50	3	53	5.7%
NORTH COAST	161	7	168	4.2%
SACRAMENTO VALLEY	1,802	491	2,293	21.4%
SAN JOAQUIN VALLEY	1,880	2,456	4,336	56.6%
SO. CAL. COASTAL	41,849	4,695	46,544	10.1%
SO. CAL. DESERT	80,894	14	80,908	0.0%
UNKNOWN	3	-	3	0.0%
Grand Total	158,225	9,747	167,972	5.8%

Agricultural Connections:

REGION	Ag. Metered	Ag. Unmetered	Total	% Unmetered
BAY AREA	2	-	2	0.0%
CENTRAL COAST	820	2	822	0.2%
FOOTHILLS	-	-	-	#DIV/0!
MOUNTAINS/EASTERN DESERT	1,310	-	1,310	0.0%
NORTH COAST	12	-	12	0.0%
SACRAMENTO VALLEY	1,438	6	1,444	0.4%
SAN JOAQUIN VALLEY	97	1	98	1.0%
SO. CAL. COASTAL	8,134	-	8,134	0.0%
SO. CAL. DESERT	13,076	6	13,082	0.0%
UNKNOWN	-	-	-	#DIV/0!
Grand Total	24,889	15	24,904	0.1%

Total Connections (2000 Data):

REGION	Total Metered	Total Unmetered	Total	% Unmetered
BAY AREA	742,444	17,112	759,556	2.3%
CENTRAL COAST	315,438	1,869	317,307	0.6%
FOOTHILLS	39,714	41,938	81,652	51.4%
MOUNTAINS/EASTERN DESERT	22,278	6,012	28,290	21.3%
NORTH COAST	55,164	2,555	57,719	4.4%
SACRAMENTO VALLEY	139,315	129,579	268,894	48.2%
SAN JOAQUIN VALLEY	536,559	313,324	849,883	36.9%
SO. CAL. COASTAL	2,797,809	11,823	2,809,632	0.4%
SO. CAL. DESERT	726,222	7,019	733,241	1.0%
UNKNOWN	17,239	-	17,239	0.0%
Grand Total	5,392,182	531,231	5,923,413	9.0%

1997 DWR PWS Production Survey Data Summary

Single Family Connections:

REGION	SF Metered	SF Unmetered	Total	% Unmetered
BAY AREA	1,101,298	5,329	1,106,627	0.5%
CENTRAL COAST	156,742	454	157,196	0.3%
FOOTHILLS	65,016	42,833	107,849	39.7%
MOUNTAINS/EASTERN DESERT	11,492	3,614	15,106	23.9%
NORTH COAST	48,425	2,317	50,742	4.6%
SACRAMENTO VALLEY	91,538	237,209	328,747	72.2%
SAN JOAQUIN VALLEY	180,192	175,036	355,228	49.3%
SO. CAL. COASTAL	2,140,266	2,453	2,142,719	0.1%
SO. CAL. DESERT	494,846	6,769	501,615	1.3%
UNKNOWN	36,621	581	37,202	1.6%
Grand Total	4,326,436	476,595	4,803,031	9.9%

Multi Family Connections:

REGION	MF Metered	MF Unmetered	Total	% Unmetered
BAY AREA	99,079	-	99,079	0.0%
CENTRAL COAST	21,538	4	21,542	0.0%
FOOTHILLS	1,186	953	2,139	44.6%
MOUNTAINS/EASTERN DESERT	594	505	1,099	46.0%
NORTH COAST	2,938	2	2,940	0.1%
SACRAMENTO VALLEY	6,741	32,655	39,396	82.9%
SAN JOAQUIN VALLEY	18,899	3,303	22,202	14.9%
SO. CAL. COASTAL	270,060	19,448	289,508	6.7%
SO. CAL. DESERT	19,840	512	20,352	2.5%
UNKNOWN	4,372	-	4,372	0.0%
Grand Total	445,247	57,382	502,629	11.4%

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Commercial Connections:

REGION	Comm. Metered	Comm. Unmetered	Total	% Unmetered
BAY AREA	87,819	25	87,844	0.0%
CENTRAL COAST	32,205	3	32,208	0.0%
FOOTHILLS	5,732	590	6,322	9.3%
MOUNTAINS/EASTERN DESERT	1,728	649	2,377	27.3%
NORTH COAST	4,052	24	4,076	0.6%
SACRAMENTO VALLEY	19,449	3,559	23,008	15.5%
SAN JOAQUIN VALLEY	23,046	3,980	27,026	14.7%
SO. CAL. COASTAL	162,602	559	163,161	0.3%
SO. CAL. DESERT	32,355	1,159	33,514	3.5%
UNKNOWN	3,503	413	3,916	10.5%
Grand Total	372,491	10,961	383,452	2.9%

Industrial Connections:

REGION	Ind. Metered	Ind. Unmetered	Total	% Unmetered
BAY AREA	12,921	-	12,921	0.0%
CENTRAL COAST	874	-	874	0.0%
FOOTHILLS	51	-	51	0.0%
MOUNTAINS/EASTERN DESERT	20	12	32	37.5%
NORTH COAST	122	31	153	20.3%
SACRAMENTO VALLEY	504	10	514	1.9%
SAN JOAQUIN VALLEY	1,008	60	1,068	5.6%
SO. CAL. COASTAL	17,612	474	18,086	2.6%
SO. CAL. DESERT	2,171	245	2,416	10.1%
UNKNOWN	171	-	171	0.0%
Grand Total	35,454	832	36,286	2.3%

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Landscape Connections:

REGION	Landscape Metered	Landscape Unmetered	Total	% Unmetered
BAY AREA	15,476	1	15,477	0.0%
CENTRAL COAST	2,892	30	2,922	1.0%
FOOTHILLS	816	2	818	0.2%
MOUNTAINS/EASTERN DESERT	87	-	87	0.0%
NORTH COAST	145	13	158	8.2%
SACRAMENTO VALLEY	1,995	314	2,309	13.6%
SAN JOAQUIN VALLEY	2,481	95	2,576	3.7%
SO. CAL. COASTAL	23,052	80	23,132	0.3%
SO. CAL. DESERT	6,531	46	6,577	0.7%
UNKNOWN	294	-	294	0.0%
Grand Total	53,769	581	54,350	1.1%

Other Connections:

REGION	Other Metered	Other Unmetered	Total	% Unmetered
BAY AREA	15,908	60	15,968	0.4%
CENTRAL COAST	2,815	18	2,833	0.6%
FOOTHILLS	606	3,312	3,918	84.5%
MOUNTAINS/EASTERN DESERT	9	14	23	60.9%
NORTH COAST	167	7	174	4.0%
SACRAMENTO VALLEY	240	1,904	2,144	88.8%
SAN JOAQUIN VALLEY	657	17,877	18,534	96.5%
SO. CAL. COASTAL	25,152	1,896	27,048	7.0%
SO. CAL. DESERT	5,435	8	5,443	0.1%
UNKNOWN	276	-	276	0.0%
Grand Total	51,265	25,096	76,361	32.9%

Agricultural Connections;

REGION	Agr. Metered	Agr. Unmetered	Total	% Unmetered
BAY AREA	430	48	478	10.0%
CENTRAL COAST	627	37	664	5.6%
FOOTHILLS	338	18	356	5.1%
MOUNTAINS/EASTERN DESERT	-	20	20	100.0%
NORTH COAST	1	37	38	97.4%
SACRAMENTO VALLEY	1,325	48	1,373	3.5%
SAN JOAQUIN VALLEY	30	70	100	70.0%
SO. CAL. COASTAL	11,578	129	11,707	1.1%
SO. CAL. DESERT	6,550	49	6,599	0.7%
UNKNOWN	-	7	7	100.0%
Grand Total	20,879	463	21,342	2.2%

Total Connections (1997 Data):

REGION	Total Metered	Total Unmetered	Total	% Unmetered
BAY AREA	1,332,931	5,463	1,338,394	0.4%
CENTRAL COAST	217,693	546	218,239	0.3%
FOOTHILLS	73,745	47,708	121,453	39.3%
MOUNTAINS/EASTERN DESERT	13,930	4,814	18,744	25.7%
NORTH COAST	55,850	2,431	58,281	4.2%
SACRAMENTO VALLEY	121,792	275,699	397,491	69.4%
SAN JOAQUIN VALLEY	226,313	200,421	426,734	47.0%
SO. CAL. COASTAL	2,650,322	25,039	2,675,361	0.9%
SO. CAL. DESERT	567,728	8,788	576,516	1.5%
UNKNOWN	45,237	1,001	46,238	2.2%
Grand Total	5,305,541	571,910	5,877,451	9.7%

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Definition of Regions

COUNTY	REGION
ALAMEDA	BAY AREA
ALAMEDA/CONTRA COSTA	BAY AREA
BUTTE	SACRAMENTO VALLEY
BUTTE (IN PART)	SACRAMENTO VALLEY
CALAVERAS	SAN JOAQUIN VALLEY
COLUSA	SACRAMENTO VALLEY
CONTRA COSTA	BAY AREA
DEL NORTE	NORTH COAST
EL DORADO	FOOTHILLS
FRESNO	SAN JOAQUIN VALLEY
GLENN	SACRAMENTO VALLEY
HUMBOLDT	NORTH COAST
IMPERIAL	SO. CAL. DESERT
INYO	MOUNTAINS/EASTERN DESERT
KERN	SAN JOAQUIN VALLEY
KERN/SAN BERNARDINO	SAN JOAQUIN VALLEY
KINGS	SAN JOAQUIN VALLEY
LAKE	NORTH COAST
LASSEN	MOUNTAINS/EASTERN DESERT
LOS ANGELES	SO. CAL. COASTAL
LOS ANGELES (UNICORPORATED)	SO. CAL. COASTAL
LOS ANGELES/ORANGE	SO. CAL. COASTAL
MADERA	SAN JOAQUIN VALLEY
MARIN	BAY AREA
MARIPOSA	FOOTHILLS
MENDOCINO	NORTH COAST
MERCED	SAN JOAQUIN VALLEY
MODOC	MOUNTAINS/EASTERN DESERT
MONO	MOUNTAINS/EASTERN DESERT
MONTEREY	CENTRAL COAST
NEVADA	FOOTHILLS
ORANGE	SO. CAL. COASTAL
PLACER	FOOTHILLS
PLACER/EL DORADO	FOOTHILLS
PLUMAS	MOUNTAINS/EASTERN DESERT
RIVERSIDE	SO. CAL. DESERT

COUNTY	REGION
SACRAMENTO	SACRAMENTO VALLEY
SACRAMENTO/PLACER	SACRAMENTO VALLEY
SAN BENITO	CENTRAL COAST
SAN BERNARDINO	SO. CAL. DESERT
SAN BERNARDINO/RIVERSIDE	SO. CAL. DESERT
SAN DIEGO	SO. CAL. COASTAL
SAN FRANCISCO	BAY AREA
SAN JOAQUIN	SAN JOAQUIN VALLEY
SAN LUIS OBISPO	CENTRAL COAST
SAN MATEO	BAY AREA
SANTA BARBARA	CENTRAL COAST
SANTA CLARA	BAY AREA
SANTA CRUZ	CENTRAL COAST
SHASTA	SACRAMENTO VALLEY
SISKIYOU	MOUNTAINS/EASTERN DESERT
SOLANO	BAY AREA
SONOMA	BAY AREA
STANISLAUS	SAN JOAQUIN VALLEY
SUTTER	SACRAMENTO VALLEY
TEHAMA	SACRAMENTO VALLEY
TRINITY	NORTH COAST
TULARE	SAN JOAQUIN VALLEY
TUOLUMNE	MOUNTAINS/EASTERN DESERT
VENTURA	SO. CAL. COASTAL
YOLO	SACRAMENTO VALLEY

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POLICY ANALYSIS FOR THE PUBLIC AND PRIVATE SECTORS
M.CUBED

Date: December 13, 2002

To: Eric Poncelet, CONCUR, Inc.
Fr: David Mitchell, M.Cubed
Re: Cost of meter installation for different areas of CA

The following summarizes information on the costs of meter installation from water districts in various parts of the state. The memo concludes with a back-of-envelope estimate of the regional cost to retrofit existing single family unmetered accounts.

Table 1. Meter Retrofit Costs Reported by Various Water Suppliers

Water Supplier	Region	Avg. Cost Per Meter Installation	Notes
Sacramento Suburban	Sacramento Valley	$910 per residential meter	Most residential connections in backyards. Meter, box, and meter setter cost $240. Installation, which includes up to 28 sq ft of landscape restoration is $670.
San Juan Water District	Sacramento Valley	$246 to install residential meter and box plus additional $207 if service upgrade required. Combined cost is $453.	Cost information provided by field operations manager for San Juan Water District
Citrus Heights Water District	Sacramento Valley	$890 (contractor install) $533 (district staff install) These are costs for residential meters	Based on 6,996 contractor and 2,056 district staff installations. Cost for contractor installation includes district inspection cost of about $40/meter.
City of Carmichael	Sacramento Valley	3/4", 1" - $1,500	Detailed cost

		11/2", 2" - $2,000 3" - $1,775 4" - $2,500	spreadsheet with itemization available.
City of Roseville	Sacramento Valley	<$775 per residential meter	Estimated cost was $775, but actual cost turning out to be somewhat less
Fair Oaks Water District	Sacramento Valley	$700 per residential installation	Install cost can run as high as $1,500 when landscape or hardscape need to be replaced.
City of Davis	Sacramento Valley	$450 per residential installation (1994 dollars)	All installations were front easements.
City of Fresno	San Joaquin Valley	$300-$350 per retrofitted residential meter (1990 dollars) $150 per new residential installation	

Back-of-Envelope Estimated Regional Cost to Retrofit Single-Family ConnectionsU

The following table provides a rough estimate of the capital costs to retrofit existing unmetered single family accounts. The calculation uses the following assumptions:

Avg. retrofit cost = $600 per connection
Avg. meter life = 15 years
Discount rate = 6%
Avg. water savings = 20% of unmetered average annual use
No. of unmetered accounts = from DWR water production survey
Avg. use per unmetered account = from CUWCC annual report data for 1999-2000.

M.CUBED POLICY ANALYSIS FOR THE PUBLIC AND PRIVATE SECTORS

Table 1. Back-of-envelope Estimate of Regional Cost to Install Meters on Existing Unmetered Single Family Accounts

Region	SF Unmetered	Capital Cost	Annualized Cost	Avg. Residential Use Per Unmetered Acct (GPD)	Annual Water Savings (AFY)	Cost Per AF
Bay Area	13,866	$6,933,000	$713,841	No Estimate	No Estimate	No Estimate
Central Coast	1,262	$631,000	$64,970	339	96	$ 815
Foothills	39,392	$19,696,000	$2,027,955	Use Sac. Valley	6,976	$ 349
Mountains/Eastern Desert	4,973	$2,486,500	$256,017	No Estimate	No Estimate	No Estimate
North Coast	542	$271,000	$27,903	No Estimate	No Estimate	No Estimate
Sacramento Valley	125,475	$62,737,500	$6,459,626	791	22,220	$ 349
San Joaquin Valley	304,284	$152,142,000	$15,664,961	806	54,958	$ 342
So. Cal. Coastal	2,900	$1,450,000	$149,296	No Estimate	No Estimate	No Estimate
So. Cal. Desert	6,213	$3,106,500	$319,854	821	1,143	$ 336

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POLICY ANALYSIS FOR THE PUBLIC AND PRIVATE SECTORS
M.CUBED

Date: February 3, 2003

To: Eric Poncelet, CONCUR, Inc.
Fr: David Mitchell, M.Cubed
Re: Cost of submeter installation

Cost of Submetering Multi Family Housing Units

Bennett (2001) reports submetering systems installed at time of construction range in cost from $125 to $250 per unit. The cost to retrofit existing property is reported to range from $175 to $400 per unit. Water Resources Engineering (2002) estimated the cost to retrofit existing property to range from $225 to $500 per unit. Additionally, Water Resources Engineering noted an annual operation and maintenance cost of $24 to $36 per unit per year, and a useful life of the equipment of 10 years.

The primary cost determinant appears to be whether the submetering system is installed in new or existing construction. The cost range for new construction is approximately half that for existing construction. We were unable to identify any literature discussing regional differences in costs for submetering. Such differences, if they exist, would be primarily related to differences in regional labor rates for construction.

Water Savings from Submetering

Bennett (2001) reports submetering of multi-family housing can reduce water use by 10 to 30 percent. The basis for this savings range is not stated. Gooding and Lee (1999) report that a study sponsored by the National Apartment Association estimated that submetered apartments evaluated in Florida, Texas, and California used 18 to 39 percent less water than similar apartments that included water cost with monthly rent. Aquacraft (2001) estimated that submetering of two mobile home parks in Las Vegas reduced water use by 7 to 12 percent compared to baseline demand levels.[1] Water Resources Engineering (2002) state that submetering multi family housing units can yield water savings ranging between 2,400 and 4,800 gallons per year per unit. Baseline demands for this estimate are not stated, so it is not possible to translate this estimate to a percentage change in unmetered demand.

Unit Cost of Water Savings from Submetering

The water savings and retrofit cost information presented in Water Resources Engineering (2002) can be used to calculate a range for the unit cost of water savings from submetering multi-family housing. The

[1] Both parks had underwent conservation plumbing retrofits prior to the submetering study, which the study's authors noted may have dampened the conservation response somewhat. The authors also noted, however, that both parks were retirement communities with year round residents, which may have had the opposite effect on savings.

lower-bound of this range is derived by dividing the annualized cost for the low-end of the cost range by the high-end of the savings range. The upper-bound is derived by doing the opposite, dividing the high-end of the cost range by the low-end of the savings range. A mid-point unit cost is calculated using the mid-points of the cost and savings ranges presented in Water Resources Engineering (2002). Annualized capital costs are based on a 6 percent discount rate. The results are shown in the following table.

Submetering Multi-Family	Low	Mid	High
Unit Cost ($/gallon)	$0.01	$0.02	$0.04
Unit Cost ($/AF)	$3,705	$7,175	$14,113

References:

Aquacraft Water Engineering and Management (2001), "Impacts of Sub-Metering on Residential Water Demand (Draft)," Submitted to Southern Nevada Water Authority.

Bennett, Dick (2001), "WATER SUBMETERING AND BILLING ALLOCATION: A Discussion of Issues and Recommended Industry Guidelines," Draft AWWA White Paper for Discussion.

Gooding, Jack, Eileen Lee (1999), "Multi Family Housing: Direct Billing Spurs Water Conservation," NREI On-line, September 1999.

United States Environmental Protection Agency (1998), "Memorandum: Submetering Water Systems," Office of Groundwater and Drinking Water.

Water Resources Engineering, Inc. (2002), "Overview of Retrofit Strategies: A Guide For Apartment Owners and Managers," Prepared for U.S. Department of Housing and Urban Development, Office of Policy Development and Research, Washington D.C.

Date: December 18, 2002

To: Eric Poncelet, CONCUR, Inc.
Fr: David Mitchell, M.Cubed
Re: Cost-Benefit Analyses of Recent Metering Proposals by California Water Agencies

This memorandum summarizes results from cost-benefit analyses of metering proposals contained in applications submitted during the 2001-2002 PSP/Prop. 13 Grant Programs. This memorandum is supported by supplemental documents provided to CONCUR.

App. #	Region	Meter Type	No. of Meters	Water Savings	NPV
WUE01-0057	Sacramento	Residential	28,799	1,735-5,180 AFY	< 0
WUE01-0098	Sacramento	Residential	425	77 AFY	> 0
WUE01-0106	Sacramento	Residential	475	122 AFY	> 0
PSP-102	So. Cal.	Residential	5,200	800 AFY	± depending on assumptions
PSP-107	Bay Area	Residential	104	10 AFY	Unknown
PSP-113	Delta	Residential	200	50 AFY	>0
PSP-114	Bay Area	Residential	7,373	1,083 AFY	>0
PSP-136	North Coast	Residential	1,000	56 AFY	>0
PSP-162	Sacramento	Residential	1,600	276 AFY	<0
PSP-168	Delta	Commercial	250	122 AFY	>0
PSP-171	Sacramento	Residential	2,850	1,084 AFY	Unknown
PSP-176	Central Coast	Commercial	7	Unspecified	>0[2]

2001 PSP APPLICATIONS

WUE01-0057

This proposal would install meters and initiate volume-based rates for 28,779 unmetered accounts in the Sacramento region. Annual water savings were estimated to be between 1,735 af/yr and 5,180 af/yr. The annualized cost per acre foot of saved water was estimated by CALFED staff to range between $307/af and $916/af depending on the savings estimate adopted. The applicants stated current local avoided cost of supply was $175/af.

Benefits of metering are based on avoided costs of a proposed conjunctive use project intended to develop new supply for the region. It does not appear that the analysis considered potential avoided treatment and distribution costs.

[2] Project benefits derive from enhanced revenue collection.

At the assumed avoided cost of supply and including the stated power and instream flow benefits, the proposed metering project had a b/c ratio of 0.85. If the regional avoided cost estimate were closer to $225/af rather than $175/af, the project would have a positive NPV.

WUE01-0098

This proposal would install meters and initiate volume-based rates for 425 unmetered residential accounts in the Arden Cordova area of Sacramento Valley. Annual water savings were estimated to be 77 af/yr. Total water savings over the 20-year life of the meters was estimated to be 1,500 af. The annualized cost per af of saved water is $420/af. The current local avoided cost of supply was $500/af. Local benefits considering only avoided water supply purchase costs exceed project cost. This project was determined by CALFED staff to be locally cost-effective to implement.

WUE01-0106

This project would install meters and initiate volume-based rates for 475 unmetered residential accounts near the City of Davis in the Sacramento Valley. Annual water savings were estimated to be 135 af/yr. Total water savings over the 20-year life of the meters was estimated to be 2,702. The annualized cost per af of saved water was $290/af. This compared to a current local avoided cost of supply of $331/af. CALFED staff determined that local benefits arising from avoided water supply purchase costs exceeded project cost. CALFED staff considered this project locally cost-effective to implement.

2002 PROP 13 APPLICATIONS

PSP-102

This proposal would meter previously unmetered connections in a service area near Ventura, CA. Applicant estimated metering would reduce water deliveries by 8,000 af over 10 years. The project was locally cost-effective to the applicant if one assumed they achieve their high-end estimate of water savings. The proposal included as a benefit the avoided cost from not manually reading meters (system would use automatic meter reading). This is an error because the applicant did not currently read meters and thus would not actually avoid this cost. The proposal estimated an average installation cost of $737/meter but did not provide any information on how this estimate was derived.

CALFED staff review of proposal concluded the expected NPV of the project ranged between negative $130,268 at 20% savings level and positive $712,051 at the 25% savings level. These estimates included a 4% annual increase in the cost of water and a 20 year savings horizon, per applicant assumptions. It was unclear whether the 4% escalation rate for the cost of purchased water referred to a real and not nominal annual cost increase. Without the annual increase in real cost of water, NPV<0 for both savings assumptions. The likelihood of NPV > 0 for this project therefore depended primarily on the assumed annual increase of 4% in the real cost of water. The analysis did not discuss the basis or justification for the 4% increase assumption.

PSP-107

This proposal would meter existing connections on a very small system in Sonoma County and extend service to 45 new connections which currently have contaminated or insufficient private source water. The application noted that connection charges from new users would equal six times the project cost, implying NPV > 0. However, CALFED staff noted that some portion of connection charges (perhaps 100%) would be used to cover cost of new connections and other infrastructure needed to serve new customers. Hence, benefits could be much less than stated by applicant. Estimated water savings were based on estimates listed in DWR Bulletin 160-98, Appendix 4B-2. Expected water savings were

considered plausible by CALFED staff. Expected benefits have not been monetized, however, making it impossible to compare directly against cost of project.

PSP-113

This proposal would meter approximately 200 existing connections on Bethel Island in the Delta at an estimated cost of $225 per meter. Applicant estimated the project would reduce outdoor water use by approximately 50%. As represented by the applicant, the project would be cost-effective, with a B/C ratio between 1.1 and 3.7. The low end of the range is based just on avoided system operating costs associated with projected reductions in delivery. The high end of the range also incorporates benefits from downsizing main replacement and proposed treatment facilities. The estimated project costs and benefits appear credible and realistic. The present value analysis conformed to the Prop. 13 application guidelines.

PSP-114

This proposal would install 7,373 meters on existing connections in the City of Rohnert Park, Sonoma County. Expected annual water savings were 1,083 acre feet per year. Over the assumed 15 year life of the meters the project would reduce demand by a total of 16,245 acre feet. The applicant also estimated the project would reduce waste water treatment requirements by 5,361 acre-feet over the life of the project.

As represented by the applicant, this project would be cost-effective, with a B/C ratio of 1.6. The estimated project costs and benefits appear credible and realistic. The present value analysis conforms to Prop. 13 application guidelines. 80% of the project benefits would accrue to the applicant, 20% to the region. A weakness in this analysis is the applicant's failure to explain/justify the basis for avoided cost of water and wastewater. However the estimates are plausible and within the expected range of costs for urban agencies.

PSP-136

This project would replace 1,000 faulty or non-functioning meters in a small service area located in Humboldt County. The application estimated the project would yield water savings of 56 acre feet per year. CALFED staff determined the project would be cost-effective to the applicant with a B/C ratio of 1.3. The estimated project costs and benefits appear credible and realistic. The present value analysis conforms to the Prop. 13 application guidelines. Water supply project benefits would accrue to the applicant.

PSP-162

This proposal would install 1600 meters in currently unmetered single-family residential accounts in the Sacramento Valley. The applicant estimated the project would yield 5,511 acre-feet in water savings over 20 years. CALFED staff concluded this project would not be locally cost-effective to the applicant. While the applicant stated a B/C ratio of 1.04, this was based on excluding project costs that would be covered by the Prop. 13 grant. When these costs are added to the costs that would be paid directly by the applicant, the B/C ratio is 0.4. The estimated project costs and benefits appear credible and realistic. The present value analysis conformed to the Prop. 13 application guidelines. Water supply project benefits would accrue to the applicant. Wastewater project benefits would accrue to regional wastewater service providers. Water quality and water supply benefits would contribute CALFED water supply and water quality program objectives.

PSP-168

This project would install meters on 250 unmetered commercial service connections in the City of Lodi. The applicant estimated this project would yield 122 acre feet in water savings over 20 years. At the applicant's stated cost of water this project is cost effective to the applicant with a B/C ratio of 1.3. The benefit calculations for this project derive from (1) assumed water savings, and (2) assumed avoided cost of supply. The analysis assumed metering would reduce demand by these connections 20%. This is consistent with published meter studies. The estimate of water savings also assumed that the applicant would begin district-wide volumetric pricing for wastewater service following installation of the meters and that this would reduce demand by 2%. The applicant stated an avoided cost of supply of $500 per acre foot. No explanation or data to support this estimate was contained in the application. It is not possible with the information contained in the proposal to assess the validity of this estimate. The applicant's present value analysis of project benefits and costs conform to the Prop. 13 application guidelines. Water supply and wastewater project benefits would accrue to the applicant.

PSP-171

This project would install meters on approximately 3,850 unmetered customers in the City of Yuba. The applicant estimated this project would reduce demand 30% for these customers. This is higher than average savings of 20% from metering listed by CUWCC, but still within the range of observed savings cited in the literature. Applicant estimated this project would reduced diversions and/or groundwater pumping by 27,100 acre-feet over 25 years. Applicant also stated project would potentially allow the downsizing and/or deferral of a planned expansion of its treatment plant. Applicant estimated metering would allow it to avoid approximately $3.2 million in treatment plant expansion costs, but did not state when these savings would occur. Therefore it is not possible to compute the present value of this avoided cost. Applicant also stated project would result in lower system O&M, but did not state what these avoided costs would be. This application does not include a present value analysis of project benefits and costs. While the information presented in the application suggests strongly that this project would be cost-effective to the applicant, there is insufficient data in the proposal to verify this supposition.

PSP-176

This project would replace 7 large meters that are currently not registering or under-registering consumption in a service area near Santa Barbara. The meter replacements would increase annual revenues to the district by approximately $100,000 to $150,000, depending on the extent to which these accounts curb demand in response to higher bills. If the accounts reduce demand, the applicant would realize an avoided cost benefit. Considering only the increased revenue collected by the district, this project has a B/C ratio to the applicant between 5.8 and 8.6. The estimated project costs and benefits appear credible. Water supply project benefits would accrue to the applicant. Wastewater project benefits would accrue to regional wastewater service providers.

WUE PSP 2001 - Economic Review Summary

Proposal #	Proposal Title	Project Category	Assigned Reviewer	Reviewed	Evaluation Complete	Funding Request	Funding Priority Based on Project Economics	Is There Reason Not to Fund this Proposal	Evaluation Summary
WUE01-0057	Four Projects for Sacramento Area Water Use Efficiency	Metering	DM	Yes	Yes	$7,031,860	Low	No	For meter retrofit element of this project, CALFED's annualized cost per acre-foot if the project achieves the upper-bound savings is $110/AF. If the project achieves the lower-bound savings, it is $375/af. The proposed cost share by the applicant is consistent with the applicant's representation of local benefits. However, the estimate of avoided cost of supply seems low to this reviewer. The benefits of the other three programs were qualitatively described by applicant. Principally they consist of regional coordination and implementation of BMPs through a regional manager and training programs. The cost to CALFED to fund these BMP support programs for three years would be $504,260.
WUE01-0098	Meter Installation for SF Residences	Metering	DM	Yes	Yes	$131,500	Low	Yes	Annual water savings are estimated to be 77 af/yr. Total water savings over the 20-year life of the meters is estimated to be 1500. The annualized cost to CALFED @ 6% if this project performs as described would be $160/AF. Solely from the perspective of water supply, this is inexpensive. However, reviewers should note that local benefits of this project are sufficiently large to make this project locally cost-effective to implement. The proposed cost share is not commensurate with local benefits of this project. The annualized cost per af of saved water is $420/af. This compares to a current local avoided cost of supply of $500/af. Local benefits just from avoided water supply costs exceed project cost. This project is locally cost-effective to implement.
WUE01-0106	Meter Installation	Metering	DM	Yes	Yes	$178,125	Low	Yes	Annual water savings are estimated to be 135 af/yr. Total water savings over the 20-year life of the meters is estimated to be 2,702. The annualized cost to CALFED @ 6% if this project performs as described would be $115/AF. Solely from the perspective of water supply, this is inexpensive. However, reviewers should note that local benefits of this project are sufficiently large to make this project locally cost-effective to implement. The annualized cost per af of saved water is $290/af. This compares to a current local avoided cost of supply of $331/af. Local benefits just from avoided water supply costs exceed project cost. If wastewater benefits are added, the project becomes even more favorable to local beneficiaries. This project is locally cost-effective to implement.

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POLICY ANALYSIS FOR THE PUBLIC AND PRIVATE SECTORS
M.CUBED

Date: October 21, 2002

To: Eric Poncelet, CONCUR, Inc.
Fr: David Mitchell, M.Cubed

Re: Water conservation benefits of metering/volumetric billing

Brown and Caldwell (1984) summarized published findings on the effect of water meters on water use. The following table reproduces Table 4-1 in Brown & Caldwell (1984).

Study Location	Study Duration	Sample size	Water Savings %
Small cities			
Milan, Tennessee	1946-1948	Citywide	45%
Kingston, New York	1958-1963	Citywide	27%
Zanesville, Ohio	1958-1961	Citywide	22.5%
Large Cities			
Philadelphia, Penn	1955-1960	27% of service area	28.5-45%
Boulder, Co	1950s-1960s	Citywide	36%
Calgary, Alberta	1968	14,755 metered, 61,575 flat-rate	45%
Central Valley cities, California	1970	Citywide	30%
Denver			
John Hopkins Study	1961-1966	Four flat-rate neighborhoods, study areas in other western cities	Little difference noted between metered and flat-rate residential in-house use; however, sprinking use was much less for metered residences
Green's Thesis	1972	Three of four flat-rate areas from John Hopkins project plus surrounding metered areas	13-30%
Beck Report	1966-1968	Two flat-rate	Results similar to

		areas plus two metered areas from Aurora	John Hopkins study.
Bryson's Thesis	1971	90,290 flat-rate residential service, 19,080 metered residences	25%

Brown and Caldwell (1984) conducted a three-year metering study in Denver. This study concluded that metered water customers in Denver use an average of about 20% less water than similar flat-rate water users. The principal effect of metering is to reduce the amount of water used for landscape irrigation. This result was also found in the Johns Hopkins and Beck studies.

Brown and Caldwell (1984) estimated the following relationship between Net ET and water use for metered and unmetered residences.

Unmetered: $y = 30.4x - 0.1$; $r2 = 0.97$

Metered: $y= 24.2x - 2.0$; $r2 = 0.96$

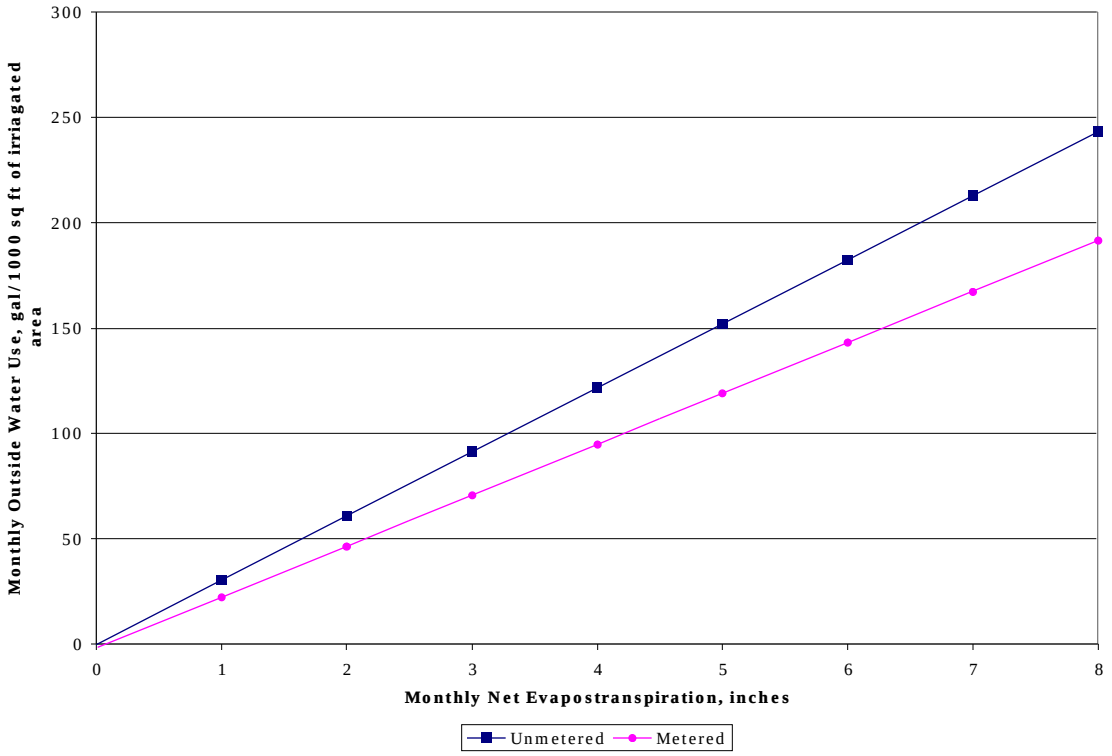
where

x = monthly net ET, inches

y = monthly outside water use, gallons per 1,000 square feet of irrigated area per day

The relationship is shown in Figure 1.

Figure 1. Brown & Caldwell (1984) Estimated Relationship between Outdoor Water Use and Metering



Lund (1984) also compiled meter study findings from the literature. Table 2 from Lund (1986) is reproduced below.

Table 2. Estimates of Use Reduction from Water Metering

City	Year	% Reduction	Reference
Kingston, NY	1958-63	20%	Cloonan, 1965
Philadelphia	1955-60	28%	Cloonan, 1965
Boulder, CO	1960-65	40%	Hanke & Flack, 1968
various, USA	1963-65	34%	Howe & Linaweaver, 1967
Israeli apts.	-	14-34%	Darr et al., 1975
Malmoe, Sweden	1980	34%	Hjorth, 1982
Solomon Is.	1969-70	50%	Berry, 1972
Flyde, UK	1970-72	10%	Smith, 1974
Malvern, UK	-	20%	Smith, 1974
Malvern, UK	1970-75	6%	Phillips & Kershaw, 1976

Lund (1986) makes the following observations about metered M&I water use.

- Changes in water use with the installation of meters seems to vary with climatic and economic conditions
- Decreases in use seem less related to the level of the new marginal price of water that to the new marginal price of water being non-zero. This implies that much of the conservation experienced accrues from either low-value uses of water (e.g. deferring leak repair and extensive lawn irrigation) or psychological factors arising from a new causal relation between water use and billing.

The following tables summarize additional results from published studies examining differences in water consumption for metered and unmetered utility customers.

Universal Metering of Customer Connections

Literature Citation	Summary of Findings
Bishop, W. J., and J.A. Weber (1995), "Impacts of Metering: A Case Study at Denver Water," prepared for the 20th Congress IWSA, Durban, South Africa.	From Council's Savings & Cost Study: Bishop and Weber (1995) report the results of a statistical analysis of Denver's universal metering program. The average annual water savings is reported as 28%, with a summer peak seasonal reduction of 38.4% in 1991. The authors cite landscape irrigation as the reason for the large summer savings with metering. The authors report that controlling for season, weather, and the effect of metering and conservation practices that 98% of the monthly variation in consumption is explained by the statistical model. However, savings estimated in the statistical model cannot be separated from savings from concurrent programs to promote the installation of conservation devices, such as bathroom retrofits. The savings reported for metering also are not separated from the effect of newly metered accounts that may have systematic difference in lot size, income, or housing density.
Lovett, D. (1992), "Water Conservation Through Universal Metering," 44th Annual Convention of the Western Canada Water and Wastewater Association Proceedings.	From Council's Savings & Cost Study: Lovett (1992) reports water savings from the addition of universal metering has ranged between 25 and 40 percent where it has been implemented in several Canadian locations.
Leblanc, L., et al. (1997), "Is Residential Metering Cost-Beneficial in Water-Rich Greater Vancouver?" Conference Proceedings of the American Water Works Association, Pacific Northwest Section	From Council's Savings & Cost Study: Leblanc (1997) notes that the Residential Water Metering Study in Greater Vancouver assumed that "residential water meters, an appropriate rate structure and bimonthly billing would result in a 20% reduction in single family residential consumption, based on the experience in other areas."
Koch, R. N. and R.F. Oulton (1990), "Submetering: Conservation's Unexplored	From Council's Savings & Cost Study: Kock and Oulton (1990) report that single family dwellings that have been converted to individual meters save on average 20 to 30

Potential," AWWA Conference Proceedings	percent.
City of Kamloops (2001), "Water Use Efficiency Committee Final Report, Appendix E."	This report summarizes differences in water consumption for communities in Canada with and without universal metering. The authors note an empirical study of a Calgary neighborhood that is half metered and half unmetered found that unmetered households used 50% more water than their unmetered counterparts, despite the residences being of similar construction, plumbing, and lot size. Extrapolating the results of the neighborhood study, the City of Calgary estimated that universal metering could lower demand for water in the city by 20% to 25%. Calgary currently operates a voluntary metering program where customers can elect to be metered and in return receive favorable rates for water. It is therefore likely that some of the difference in water use between metered and unmetered households measured by the study was a result in systematic differences in water use and conservation attitudes between those freely choosing to be metered and those choosing not to be metered. The report also summarized average and maximum day demand between 1982 and 1992 for five metered and six unmetered cities in Canada. The data show that average day demand for metered cities was 38% lower than for metered cities, while maximum day demand was 48% lower.

Master Metering Multi Family Residential Water Use (not submetering)

Literature Citation	Summary of Findings
Speedwell, Inc. (1994), "The Impact of Metered Billing for Water and Sewer on Multifamily Housing in New York," prepared for the New York City Department of Environmental Protection and the New York City Rent Guidelines Board.	From Council's Savings & Cost Study: This study analyzed data from a sample of 590 multi-family buildings in New York City and a sample of 676 multi-family buildings in Jamaica, New York. The Jamaica service area is metered and the New York City buildings were not metered. A statistical model was developed, regressing housing density, median income in the census tract, building size water use, and a dummy variable for Jamaica service area on water use. Controlling for these independent variables, metered billing resulted in a 36% decrease in water use, which the authors attribute to metered water consumption.

Referenced Literature

Berry, N.S.M. (1972), "The Effect of Metering on Water Consumption in Honiara-British Solomon Islands," Journal, of the Institution of Water Engineers, Vol. 26, No. 7 (October), pp. 375-380

Bishop, W. J., and J.A. Weber (1995), "Impacts of Metering: A Case Study at Denver Water," prepared for the 20th Congress IWSA, Durban, South Africa.

Brown & Caldwell (1984), "Effect of Water Meters on Water Use," Prepared for U.S. Department of Housing and Urban Development, Contract H-5230.

City of Kamloops (2001), "Water Use Efficiency Committee Final Report, Appendix E."

Cloonan, E.T. (1965), "Meters Save Water, " in Modern water Rates, Battenheim Publishing Co., N.Y.

Darr, Peretz, Stephen L. Feldman, and Charles S. Kamen (1975), "Socioeconomic Factors Affecting Domestic Water Demand in Israel," Water Resources Research, Vo. 11, No. 6, pp. 805.

Hanke, Steve H. and Ernest Flack Jr. (1968), "Effects of Metering Urban Water," Journal of the American Water Works Association, Vol. 60.

Hjorth, Peder (1982), Identifying och Analys av Faktorer Vilka Styr Vattenforbrukningen och Dess Variationer, Report No. 3068, Department of Water Resources Engineering, Lund Institute of Technology, University of Lund, Lund, Sweden, 47. pp.

Howe, Charles W. and F.P. Linaweaver Jr. (1965), "The Impact of Price on Residential Water Demand and Its Relation to System Design, "Water Resources Research, Vol. 1.

Koch, R. N. and R.F. Oulton (1990), "Submetering: Conservation's Unexplored Potential," AWWA Conference Proceedings

Leblanc, L., et al. (1997), "Is Residential Metering Cost-Beneficial in Water-Rich Greater Vancouver?" Conference Proceedings of the American Water Works Association, Pacific Northwest Section
Lovett, D. (1992), "Water Conservation Through Universal Metering," 44th Annual Convention of the Western Canada Water and Wastewater Association Proceedings.

Lund, J. R. (1986) "Metering Utility Services: Theory and Water Supply Applications," Water Resources Series Technical Report No. 103, University of Washington, Dept. of Civil Engineering.

Phillips, J.H. and C.G. Kershaw (1976), "Domestic Metering - An Engineering and Economic Appraisal," Journal of the Institution of Water Engineers and Scientists, Vol. 30, No. 4, pp. 203-216.

Smith, R.J. (1974), "Some Comments on Domestic Metering," Journal of the Institution of Water Engineers, Vol. 28, No. 1, pp. 47-53.

Speedwell, Inc. (1994), "The Impact of Metered Billing for Water and Sewer on Multifamily Housing in New York," prepared for the New York City Department of Environmental Protection and the New York City Rent Guidelines Board.

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POLICY ANALYSIS FOR THE PUBLIC AND PRIVATE SECTORS
M.CUBED

Date: December 20, 2002

To: Eric Poncelet
Fr: David Mitchell, M.Cubed
Re: Dependence of BMP implementation upon water use measurement

BMP implementation is dependent upon water use measurement in two ways. First, implementation of certain BMPs requires the ability to measure water use or prescribe measurement as an activity to undertake. Second, the ability to measure results of BMP implementation in terms of water saved typically requires analysis of customer water use history.

BMPs Requiring or Prescribing Measurement

BMP 3 -- System Water Audits, Leak Detection and Repair -- also requires measurement of water use if it is to be effective. Metering at the point of customer connection provides water use history needed to complete a system water audit, determine system unaccounted for water losses, and isolate system leaks. In the absence of measurement at the customer connection, the ability to implement BMP 3 in a meaningful way is substantially compromised.

BMP 4 -- Metering with Commodity Rates -- obligates MOU signatories to meter all new connections and retrofit existing connections as long as doing so is cost-effective.

BMP 5 -- Large Landscape Conservation Programs and Incentives -- requires the water supplier develop water budgets for landscape areas served by dedicated irrigation meters. In the absence of metering, this part of BMP 5 cannot be implemented.

BMP 9 -- CII Conservation Programs -- The first requirement of BMP 9 is to identify and rank commercial, industrial and institutional accounts according to water use. Obviously such a ranking cannot occur unless the utility has some ability to measure CII customer water use.

BMP 11 -- Conservation Pricing -- proscribes the use of non-volumetric pricing of water and wastewater service. In order to implement volumetric pricing a water utility needs some measure of each customer's water consumption. This is most easily determined by metering customer water use at the point of connection.

BMP Water Savings Evaluation

BMP water savings evaluations generally rely on customer water use histories before and after the BMP intervention. Statistical methods are applied to the customer water use data set to control for various influences (e.g. weather, income, lot size, etc.) on customer water use in an attempt to isolate the effect of the BMP. This type of analysis cannot be done in the absence of customer water use histories. Consequently, the ability of unmetered service areas to evaluate the effect of BMP implementation on customer water demands is very limited. All of the major water savings studies of BMP programs done to date have relied on customer billing data to determine pre- and post BMP water consumption.

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POLICY ANALYSIS FOR THE PUBLIC AND PRIVATE SECTORS
M.CUBED

Date: October 18, 2002

To: Eric Poncelet, CONCUR, Inc.
Fr: David Mitchell, M.Cubed

Re: Summary of Residential Volumetric Water Rates in California

The tables on the following pages summarize 2001 data on volumetric rates for single-family connections in California. These data were compiled by Black & Veatch and are published in its *California Water Charge Survey: 2001*. The regional classifications are not part of the Black & Veatch data. Regional classifications were constructed by M.Cubed. The last table of the memo provides a mapping of counties to regions used for the analysis. To our knowledge, survey data for customer classifications other than single-family are not available.

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Percent of Regional Population Living in a Utility Service Area Employing Given Rate Type for Single Family Connections
Source: Black & Veatch California Water Charge Survey: 2001

	RATE TYPE							
REGION	Flat monthly	Base water allowance plus uniform rate	Base water allowance plus declining rate	Base water allowance plus tiered rate	Uniform volumetric rate	Declining volumetric rate	Tiered volumetric rate	Grand Total
BAY AREA	1%	2%	0%	1%	53%	0%	43%	100%
CENTRAL COAST	0%	4%	3%	4%	28%	0%	61%	100%
FOOTHILLS	10%	10%	2%	20%	1%	1%	57%	100%
MOUNTAINS/EASTERN DESERT	12%	17%	0%	29%	0%	0%	42%	100%
NORTH COAST	14%	13%	3%	0%	41%	0%	28%	100%
SACRAMENTO VALLEY	42%	2%	1%	8%	47%	0%	0%	100%
SAN JOAQUIN VALLEY	48%	5%	1%	5%	27%	5%	9%	100%
SO. CAL. COASTAL	0%	1%	0%	0%	61%	0%	38%	100%
SO. CAL. DESERT	1%	8%	0%	2%	59%	0%	29%	100%
Grand Total	7%	2%	0%	2%	54%	0%	35%	100%

Regional Average Volumetric Rate ($/hcf) for Single-family Connections
Source: Black & Veatch California Water Charge Survey: 2001

REGION	Pop. Weighted Avg. Rate ($/hcf)	Min. Rate ($/hcf)	Max Rate ($/hcf)
BAY AREA	$1.59	$0.00	$4.43
CENTRAL COAST	$1.85	$0.26	$5.68
FOOTHILLS	$0.57	$0.00	$1.38
MOUNTAINS/EASTERN DESERT	$0.56	$0.00	$0.93
NORTH COAST	$1.10	$0.20	$3.17
SACRAMENTO VALLEY	$1.03	$0.00	$4.27
SAN JOAQUIN VALLEY	$0.29	$0.00	$3.63
SO. CAL. COASTAL	$1.55	$0.00	$3.16
SO. CAL. DESERT	$0.86	$0.00	$3.40

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Distribution of Regional Population by Single-family Rate Level

R = Volumetric Rate ($/hcf)

Source: Black & Veatch California Water Charge Survey: 2001

REGION	R=0	0<R≤0.5	0.5<R≤1.0	1.0<R≤1.5	1.5<R≤2.0	2.0<R≤2.5	2.5<R≤3.0	R>3.0	Grand Total
BAY AREA	1%		3%	54%	22%	20%	0%	0%	100%
CENTRAL COAST		4%	25%	8%	24%	13%	5%	20%	100%
FOOTHILLS	12%	24%	60%	5%					100%
MOUNTAINS/EASTERN DESERT	12%	17%	71%						100%
NORTH COAST		14%	22%	52%	3%	8%		0%	100%
SACRAMENTO VALLEY	39%	17%	16%		9%		9%	9%	100%
SAN JOAQUIN VALLEY	52%	18%	29%	1%		0%		0%	100%
SO. CAL. COASTAL	0%	1%	10%	35%	49%	4%		0%	100%
SO. CAL. DESERT	2%	5%	62%	24%	5%	0%	1%	0%	100%

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Definition of Regions

COUNTY	REGION
ALAMEDA	BAY AREA
ALAMEDA/CONTRA COSTA	BAY AREA
BUTTE	SACRAMENTO VALLEY
BUTTE (IN PART)	SACRAMENTO VALLEY
CALAVERAS	FOOTHILLS
COLUSA	SACRAMENTO VALLEY
CONTRA COSTA	BAY AREA
DEL NORTE	NORTH COAST
EL DORADO	FOOTHILLS
FRESNO	SAN JOAQUIN VALLEY
GLENN	SACRAMENTO VALLEY
HUMBOLDT	NORTH COAST
IMPERIAL	SO. CAL. DESERT
INYO	MOUNTAINS/EASTERN DESERT
KERN	SAN JOAQUIN VALLEY
KERN/SAN BERNARDINO	SAN JOAQUIN VALLEY
KINGS	SAN JOAQUIN VALLEY
LAKE	NORTH COAST
LASSEN	MOUNTAINS/EASTERN DESERT
LOS ANGELES	SO. CAL. COASTAL
LOS ANGELES (UNICORPORATED)	SO. CAL. COASTAL
LOS ANGELES/ORANGE	SO. CAL. COASTAL
MADERA	SAN JOAQUIN VALLEY
MARIN	BAY AREA
MARIPOSA	FOOTHILLS
MENDOCINO	NORTH COAST
MERCED	SAN JOAQUIN VALLEY
MODOC	MOUNTAINS/EASTERN DESERT
MONO	MOUNTAINS/EASTERN DESERT
MONTEREY	CENTRAL COAST
NAPA	BAY AREA
NEVADA	FOOTHILLS
ORANGE	SO. CAL. COASTAL
PLACER	FOOTHILLS
PLACER/EL DORADO	FOOTHILLS
PLUMAS	MOUNTAINS/EASTERN DESERT
RIVERSIDE	SO. CAL. DESERT
SACRAMENTO	SACRAMENTO VALLEY
SACRAMENTO/PLACER	SACRAMENTO VALLEY
SAN BENITO	CENTRAL COAST
SAN BERNARDINO	SO. CAL. DESERT
SAN BERNARDINO/RIVERSIDE	SO. CAL. DESERT
SAN DIEGO	SO. CAL. COASTAL
SAN FRANCISCO	BAY AREA
SAN JOAQUIN	SAN JOAQUIN VALLEY

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COUNTY	REGION
SAN LUIS OBISPO	CENTRAL COAST
SAN MATEO	BAY AREA
SANTA BARBARA	CENTRAL COAST
SANTA CLARA	BAY AREA
SANTA CRUZ	CENTRAL COAST
SHASTA	SACRAMENTO VALLEY
SISKIYOU	MOUNTAINS/EASTERN DESERT
SOLANO	BAY AREA
SONOMA	BAY AREA
STANISLAUS	SAN JOAQUIN VALLEY
SUTTER	SACRAMENTO VALLEY
TEHAMA	SACRAMENTO VALLEY
TRINITY	NORTH COAST
TULARE	SAN JOAQUIN VALLEY
TUOLUMNE	MOUNTAINS/EASTERN DESERT
VENTURA	SO. CAL. COASTAL
YOLO	SACRAMENTO VALLEY

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